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PATENT SPECIFICATION

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(54) IMPROVEMENTS IN OR RELATING TO METHODS IN THE PRODUCTION OF PLANT-MIXED ASPHALT MIXES FOR PAVING PURPOSES

(71) I, KARL GUNNAR OHLSON, of Vikingaleden 28, 281 00, Hasselholm, Sweden, A Swedish Subject, do hereby declare the invention, for which I pray that a patent may be granted to me, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to a method for the production of a plant mixed asphalt mix for paving purposes, of the kind in which both mineral aggregate and bituminous binder are heated and then mixed in heated condition.

Such hot mixing of asphalt mixes in asphalt plants is conducted under conditions entirely different from those prevailing in connection with bituminous binder solutions or emulsions instead of bituminous binder which through heating has been converted into liquid form with the requisite low viscosity. Governmental Specifications have been issued regarding the quality of the materials used for asphalt mixes for paving purposes, and these specifications are applicable also to the present invention. According to the specifications, the bituminous binder employed usually shall have the viscosity of 500 centistokes at a temperature of 120—140°C, or a penetration of 50—250. During mixing, the binder as well as the mineral aggregate shall be heated to a temperature of 140—170°C. The mineral aggregate shall consist of particles or fragments of different size, and the particle size distribution shall be adapted to a prescribed continuous sieve analysis curve. The mineral aggregate preferably consists of crushed mineral, but also gravel and sand may be used. The maximum size of the mineral particles may vary considerably for different types of asphalt mixes, for instance from a maximum size of 4 mm up to a maximum size of 25 mm, or higher. Actually, the particle size distribution of the particles of mineral aggregate extends down to 0 mm, but mineral aggregates having a particle size distribution of less than 0.09 mm are called dust when occurring in the heated mineral aggregate, and filler when added separately. Depending upon the specifications and requirements, filler is either added or omitted.

In present production methods, all mineral agregate is dried and heated and then introduced into a mixer, possibly with the addition of a separate filler, and is mixed for about 10 to 15 seconds, whereupon the designed amount of bituminous binder heated to the specified temperature is introduced into the mixer where mixing is continued for a suitable period of time.

The resulting asphalt mix is then removed from the mixer and conveyed to the construction site where the mix is laid in hot condition on a prepared base and is compacted by rolling. In order that the properties of the resulting asphalt layer be as excelenlt as possible, it is imperative that the surfaces of the mineral aggregate particles are covered as completely as possible with an adherent binder film. It has been found that the known methods of producing plant mixed asphalt mixes do not permit a complete coverage of all surfaces of the mineral aggregate with a binder film, even if the mixing time is extended far beyond what is economically justified in view of the utilisation degree for the expensive asphalt plants.

This disadvantage is eliminated by the present invention. Thus, the invention provides a method for the production of a plant mixed asphalt mix for paving purposes of the kind in which both mineral aggregate and bituminous binder are heated and then mixed in heated state in a mixer, wherein the dried and heated mineral aggregate is divided into a substantially dust-free coarse portion and a dust-containing fine portion which consists substantially of all those particles of the mineral aggregate that have a size of 2 mm and smaller, the coarse portion is admixed in the mixer with all the binder required for the mix, and all surfaces of the particles of the coarse portion being coated with a film of the binder, and then the fine portion is introduced into the mixer and encapsulated in the binder film on the surfaces of the binder-coated particles of the coarse portion, the mixer being thereafter emptied.

The method according to the invention makes it possible to thoroughly cover all of the surfaces of all mineral aggregates with a binder film. During mixing the particles of the coarse portion are coated with a binder film on all surfaces. Due to the size and weight of the particles in the coarse portion said particles remain freely movable relating to one another and do not stick together and form lumps (agglomerations). When the coarse aggregate has been truly coated with a binder film the fine portion and filler, if needed, is added. These small particles will be springled over and penetrate into the binder film of the already coated coarse portion particles and will convert said film into a creamy consistency. The ready-mixed asphalt mix may be described as a dough with the constituents in homogeneous mixture and readily breakable lump formations. Actually the dough is composed of a large number of units each consisting of one particle of the coarse portion with a continuous and wholly covering creamy asphalt layer with particles of the fine portion (and, if desired, a filler material) embedded therein, the units being held together by the creamy binder layers to form a dough necessary for preventing segregation in the subsequent handling of the mix.

The present invention offers an unforeseeable and surprisingly great improvement of the Marshall stability of the asphalt mix. If one uses the same ingredients and the same procedure, except that on one occasion the mixing is carried out in accordance with the above mentioned prior art method and on another occasion in accordance with the present invention, one finds that the ready-mixed asphalt mix of the invention results in a Marshall stability in the order 100% higher than in the other case. Moreover, the present invention brings the advantage that the total mixing time can be kept very short and that the amount of binder can be reduced, all of which contributes towards reducing the overall cost as compared to conventional methods. It has also been found that the ready-mixed asphalt mix according to the present invention is entirely free from any tendency towards separation, i.e. the homogeneity of the mix, obtained by the mixing operation, will not be disturbed by the handling to which the mix is subjected after its removal from the mixer, and the finished asphalt layer will have a reduced tendency towards "bleeding" compared to a corresponding asphalt layer, the materials of which have been mixed in conventional manner.

The present invention is based on the important discovery that the viscosity of the binder during mixing must be maintained at a low value which is attained by heating the binder to the prescribed temperature. In the prior art mixing method, the binder added to the mixture in liquid form has been found quickly to assume a creamy consistency, although no decrease in temperature occurs since the mineral aggregate has essentially the same temperature as the binder. The creamy binder has great difficulty in forming coatings on the larger fragments or particles of the mineral aggregate, and the formation of lumps in the mixer is considerable. This phenomenon, that is the conversion of the binder liquid into a creamy consistency, has been found to be due to the fact that the smallest particles of the mineral aggregate behave in a different manner, relative to the binder liquid, than the coarser particles. In contradistinction to larger particles, mineral aggregate particles below a given dimension which varies slightly from one case to another depending upon such factors as the type and specific gravity of the mineral aggregate and the type of bituminous binder, are unable—once they have been introduced into binder liquid—to leave the liquid under the action of gravity through a surface of said liquid as free binder coated particles. The small particles which, in the known mixing method, come into contact with the binder liquid already at the beginning of the mixing operation, will thus be caught by and retained in the binder liquid, causing the liquid to assume a creamy consistency before it has time to coat the larger particles with a continuous wholly covering binder film.

This discovery is utilised by the present invention in such manner that all of the mineral aggregate particles which are sufficiently large to be able to appear in the mixture as separate free binder coated particles, are first mixed with all of the binder liquid which retains its low viscosity and thus its ability to provide the particles on all surfaces with a continuous binder film, before the smaller mineral aggregate particles are introduced into the mixer. When added to the mixer, these smaller mineral aggregate particles will be sprinkled over and penetrate into the binder films on the larger particles, converting the films into creamy consistency. The increase in the viscosity of the binder at this stage of the mixing process is no obstacle to the endeavour to obtain a complete covering of all mineral aggregate particles with a binder film because the larger particles are already completely covered with binder, and the smaller particles will also be covered with binder on all surfaces since they are embedded in the binder coating of the larger particles. The increase in the viscosity of the binder at this stage is imperative since the creamy consistency which the binder films assume will obviate completely any separation tendencies in the finished mix and immediately impart to the mix, when

laid as a coating on a base, such excellent stability that the layer can be compacted without delay by rolling.

For the present invention, it is important to determine in each separate case the boundary line between the coarse portion which must first be mixed with all binder in the mixer, and the fine portion which is to be added at a later stage of the mixing operation. This determination can be effected by making several test mixes with varying boundary lines between the portions and by observing the extent to which the coarse mineral aggregate particles are covered with a binder film, whether the binder upon mixture with the coarse mineral aggregate portion changes its viscosity to creamy consistency, and how the Marshall stability develops.

The invention will be illustrated in the following example.

EXAMPLE

The mineral aggregate consists of	% by weight
Crushed mineral, particle size 2—12 mm	75.4
Sand, particle size 0.09—2 mm	18.8
Filler, particle size 0—0.09 mm	5.8

The bituminous binder used has a penetration of 80, and the binder content employed amounted to 4.5% by weight of total aggregates.

Two mixes were prepared. The first mix, Mix C, was prepared in known manner by introducing all mineral aggregate into the asphalt plant mixer and mixed for 15 seconds, whereupon the binder heated to mixing temperature was poured into the mixer and mixing was continued for 40 seconds. Mix C was then removed from the mixer and laid in conventional manner as a road surface layer on a prepared base. Mix C resulted in a Marshall stability of 390 kg.

The other mix, mix D, was prepared in accordance with the present invention. The dried and heated mineral aggregate was divided into a coarse portion of crushed mineral aggregate having particle sizes between 2 and 12 mm and a fine portion of sand and filler with particle sizes between 2 to 0 mm. The coarse portion, the particles of which were substantially dust-free, was first introduced into the asphalt plant mixer and mixed for 15 seconds, whereupon all binder was added and mixing was continued for another 15 seconds. The fine portion was then added, and mixing was continued for another 15 seconds, whereupon the mix was removed from the mixer and laid in conventional manner as a road surface layer on a prepared base. Mix D resulted in a Marshall stability of 650 kg.

By proceeding in accordance with mix D, but reducing the binder content to 3.4% by weight of total aggregates, a Marshall stability of 560 kg was obtained.

The particle sizes indicated in the above description are based upon mesh openings in usual manner. For instance, particles having a size of 2 mm are particles that can pass through a sieve having a mesh opening of 2 mm (Sieve No. 10, U.S. Standard).

WHAT I CLAIM IS:—

1. A method for the production of a plant mixed asphalt mix for paving purposes of the kind in which both mineral aggregate and bituminous binder are heated and then mixed in heated state in a mixer, wherein the dried and heated mineral aggregate is divided into a substantially dust-free coarse portion and a dust-containing fine portion which consists substantially of all those particles of the mineral aggregate that have a size of 2 mm and smaller, the coarse portion is admixed in the mixer with all the binder required for the mix, and all surfaces of the particles of the coarse portion being coated with a film of the binder, and then the fine portion is introduced into the mixer and encapsulated in the binder film on the surfaces of the binder-coated particles of the coarse portion, the mixer being thereafter emptied.

2. A method as claimed in Claim 1, wherein filler is introduced into the mixer together with the fine portion.

3. A method for the production of a plant mixed asphalt mix for paving purposes as claimed in Claim 1, substantially as described herein with reference to the Example.

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